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ABSTRACT

A light emitting diode (LED) grown on a substrate doped with one or more rare earth or transition element. The dopant ions absorb some or all of the light from the LED's active layer, pumping the electrons on the dopant ion to a higher energy state. The electrons are naturally drawn to their equilibrium state and they emit light at a wavelength that depends on the type of dopant ion. The invention is particularly applicable to nitride based LEDs emitting UV light and grown on a sapphire substrate doped with chromium. The chromium ions absorb the UV light, exciting the electrons on ions to a higher energy state. When they return to their equilibrium state they emit red light and some of the red light will emit from the LED's surface. The LED can also have active layers that emit green and blue and UV light, such that the LED emits green, blue, red light and UV light which combines to create white light. Alternatively, it can have one active layer and grown on a sapphire substrate doped with Cr, Ti, and Co such that the substrate absorbs the UV light and emits blue, green, and red light. The invention is also capable of providing a tunable LED over a variety of color shades. The invention is also applicable to solid state laser having one or more active layers emitting UV light with the laser grown on a sapphire substrate doped with one or more rare earth or transition elements.